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ENERGY CONSERVATION WISTFUL ALGORITHM (ECWA) ASSOCIATED WITH CACHE SYSTEM TO MAXIMIZE THE LIFE TIME OF AN AD-HOC NETWORK

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ABSTRACT

An ad hoc network is composed of group of mobile wireless nodes that form a network among themselves without any fixed infrastructure while forwarding packets to each other in a multi-hop manner. Each mobile node performs the routing functions for establishing communication among different nodes. Since the mobile nodes are battery powered and have limited power the “death” of even a few nodes, due to energy exhaustion might cause the disruption of service in the entire network. The increasing use of mobile devices in wireless environments led to many studies about energy-aware algorithms and protocols to improve the lifetime of device’s battery. Many Researchers and practitioners have focused on design of new energy aware protocols and algorithms for maximize the life time of ad hoc networks. This paper studies the implementation and testing of a new energy-aware algorithm, ECWA, associated with a Cache System and tested with WRP and WRP+CMMBCR routing protocols, in an ad hoc network scenario.

KEYWORDS: Ad-hoc Networks, Infrastructure, WRP, CMMBCR Etc

I. INTRODUCTION

In recent years, there has being noticed a continuous growth in the use of wireless mobile devices. With this increasing, the possibility of exchanging information between different devices has become easier, because the ability of communication should always be present. Then, there is the emergence of ad hoc networks. An ad hoc network [1] is a set of mobile wireless nodes that co-operatively form a network among themselves without any fixed infrastructure. Ad hoc networks therefore refer to networks created for a particular purpose. In such a network, each mobile host serves as a router.

Figure 1: ADHOC Network Architecture

However, maintaining an ad hoc network is a significant technical challenge, especially in ensuring the life-span of the network. Power is a limiting factor in the successful deployment of ad hoc networks since nodes are expected to have little potential for recharging their batteries. The limited battery lifetime imposes a constraint on network performance and can mean the partitioning of the network and disrupt the service of entire network.In this paper we focused on the implementation and testing of a new energy-aware algorithm, ECWA, associated with a Cache System, and tested with WRP and WRP+CMMBCR routing protocols, in an ad hoc network scenario with respect to key metrics: energy consumption, throughput, latency and packet loss.

Section 2 presents Theoretical Revision section 3 presents ECWA section 4 presents Performance evaluation and analysis. The paper concludes in section 5.

II. Theoretical Revision

A large number of researchers have addressed the problem of energy conservation to maximize the life time of ad hoc networks. Many Research works are going on to design of new energy aware protocols and algorithms [2]. Existing protocols may be classified into two distinct categories. One category of protocols is based on minimum-power routing algorithms, which focus on minimizing the energy requirements over end-to-end paths. A typical protocol in this category selects a routing path from a source to some destination so as to minimize the total energy consumption for transmitting a fixed number of packets over that path. Each link cost is set to the energy required for transmitting one packet of data across that link and Dijkstra's shortest path algorithm is used to find the path with the minimum total energy consumption. These protocols traditionally ignore the power dissipated on the receiver side in a node, and therefore, tend to result in routing paths with a large number of short hops. A key disadvantage of these protocols is that they repeatedly select the least-power cost routes between source-destination pairs.

As a result, nodes along these least-power cost routes tend to "die" soon by rapidly exhausting their battery energy. This is doubly harmful since the nodes that die early are precisely the ones that are most needed to maintain the network connectivity and hence increase the useful service life of the network.

A second category of protocols is based on routing algorithms that attempt to increase the *network lifetime* by attempting to distribute the forwarding load over multiple different paths. This distribution is performed by either intelligently reducing the set of nodes needed to perform the forwarding duties, thereby, allowing a subset of nodes to sleep over different periods of time, or by using heuristics that consider the residual battery power at different nodes and route around nodes that have a low level of remaining battery energy. In this way, they balance the traffic load inside the ad hoc network so as to increase the battery lifetime of the nodes and the overall useful life of an ad hoc network.

Routing protocols in ad hoc networks [3] are classified into three groups: *proactive* (table-driven), *reactive* (on-demand), and *hybrid*.This classification[4] [5] differentiates the routing protocols according to their technique, hop count, link state and QoS in route discovery. A proactive routing protocols is also called "table driven" routing protocols. In proactive routing protocols, all nodes need to maintain a consistent view of the network topology ex. DSDV [6], WRP [7].Reactive routing protocols are also called "on-demand" routing protocols. In reactive routing protocols, routing paths are searched only when needed ex. AODV [8], DSR[9].Hybrid routing protocols are proposed to combine the merits of both proactive and reactive routing protocols and overcome their shortcomings ex. ZRP [10], ZHLS [11].

Wireless Routing Protocol (WRP)

In this paper it will be used the protocol WRP because, in [12], it was shown that by adding the Cache System, there was a small decrease of packet loss in AODV protocol, while in the protocol WRP, there was a decrease much more significant (of 16-45%). So, the Cache System was more efficient with WRP, because WRP is more sensitive to mobility. The Cache System helps to reduce the packet loss in mobility, because, if an information is lost, the node may use the data servers of the Cache System. However, to reduce the packet loss there is an increase of the latency. This is due as there is a delay caused by the search and recovery of the information when a node searches for a specific data in the Cache System. WRP has a better performance in both delay and packet loss parameters. WRP can be strongly indicated in real-time traffic, such as transmission of voice over IP networks.

WRP is a pro-active protocol, in each node, it maintains four tables: Distance, Routing Table, Link Cost Table and Table List Relay Message (MRL) [13]. The nodes inform each other about changes in links by update messages. These messages are exchanged only between neighbours and contain the updates, and a list indicating the nodes which must recognize the updates. The MRL guard who releases an update message that must be retransmitted and which neighbours should acknowledge the relay. If there is a link failure between two nodes, they notify the neighbours, which modify their tables away and seek new paths to other nodes. Any new paths are sent back to the original nodes that update their tables. Also the nodes learn about the existence of neighbours through acknowledgments and other messages. If a node is not sending messages, it must periodically send a hello message to ensure the connectivity.

Conditional Min-Max Battery Cost Routing (CMMBCR)

CMMBCR, an energy aware routing protocol used for choosing energy efficient routes [14] [15]. The choice of routes selected by CMMBCR are one where packets get routed through paths that may be longer but that pass through nodes that have plenty of power reserves. When all hosts in possible routes have sufficient remaining battery energy (above the threshold), a route with the minimum transmission energy cost is chosen. However, if all possible routes have low remaining battery energy (below the threshold), a route with the maximum remaining battery energy is chosen in order to prolong the hosts lifetime.

Cache System

Cache system implemented in this work was based on Quorum system, which is a tool used for data replication. This set of servers which is divided into Quorum shares the data allocated in it to other nodes, keeping a copy of the data that travels on the network and creating a data repository that in this work it will be called cache system.

III. ECWA (Energy Conservation Wistful Algorithm)

In this paper was implemented a new energy-aware algorithm, ECWA, that works in conjunction with the WRP+CMMBCR routing protocol and the Cache System. The energy-aware algorithm provides an energy-aware sleep periodically when they are not receiving and sending data over the network, i.e., interrupting any processing or sending and receiving information. There are two phases in the energy-aware algorithm: the association of the node to the cache system awakening or sleeping the nodes, respectively, if the node is receiving or not the information, whether from data or determinations of new routes.

A. Association Phase of the Nodes to the Cache System

The nodes must be associated with other nodes in the cache system closer and this association occurs from time to time, because it is a mobile scenario. The cache server is responsible for controlling the nodes that should stay awake or stay asleep. The cache server receives messages of RREQ and RREP and also know what node will be part of a particular route. The time chosen for re-association of a mobility scenario is not very high, occurring from 51 to 51 seconds.

B. Sleep Phase of the Nodes who do not Belong to the Cache System

Upon receiving the RREQ or RREP messages the server's cache system updates the table of active nodes, in this table are the nodes involved in messages of RREQ or RREP where they must stay awake for 500 ms, this time was chosen according to the size of the packet sent on the network defined as being 546 Bytes (512 of data + 34 of header), using a rate of 2 MB/s. Based in the transmission speed the chosen time of 500 ms is sufficient for the packet sent be delivered to its destination node. If the node does not send and receive data, this follows a state of sleep and wake up in 95 and 105 ms, respectively; these times were chosen by the simulation tests assuming a maximum time for a node to remain awake or asleep, respectively, without damage parameters such as latency, packet loss and throughput.

IV. PERFORMANCE EVALUATION AND ANALYSIS

In this section we are going to discuss in brief regarding performance evaluation and analysis of test results. The parameters measured in the simulations are as follows:

- **Power Consumption (MWh):** is the sum total of energy consumed by the nodes during the simulation.
- **Latency (s):** represents the time spent by a packet from the source node to destination node.
- **Throughput (bps):** parameter that indicates the data transmitted effectively in a unit time.
- **Packet Loss(%):** represents the ratio of the difference between the number of packets sent and received to the number of packets sent, in percentages.

ECWA, associated with a Cache System and tested with WRP and WRP+CMMBCR routing protocols, in an ad hoc network scenario.

Figure 2 compares the results of Energy consumption scenarios between WRP, ECWA+ WRP and ECWA+ WRP+CMMBCR. There is a decrease of energy consumption with the addition of the ECWA to WRP. We can find even more decrease of energy consumption with the addition of the ECWA to WRP+CMMBCR. It is verified that, if is necessary to awake the nodes to exchange information and/or routes, there is not an increase of energy superior to the decrease in energy consumption caused the sleep of the nodes.

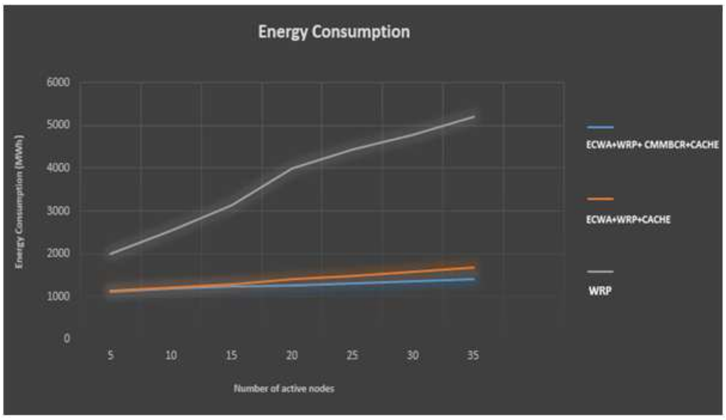

Figure 2: Comparison Graph for Energy Consumption

Figure 3 compares the results of latency scenarios between WRP, ECWA+ WRP and ECWA+ WRP+CMMBCR. There is an increase in latency with the addition of the ECWA to WRP and WRP+CMMBCR, since for awaken the nodes when they need receive data or discover new routes, a delay is added to the network. But the intervals in the graph show that the increased latency is very small.

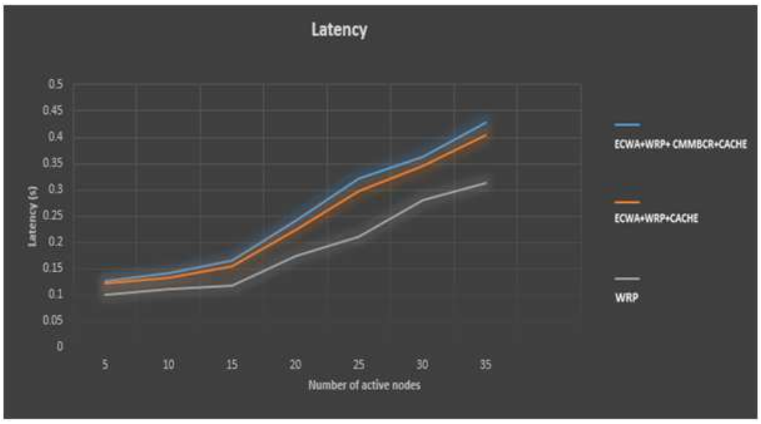

Figure 3: Comparison Graph for Latency

Figure 4 compares the results of the throughput of scenarios between WRP, ECWA+ WRP and ECWA+ WRP+CMMBCR. There is so small decrease in throughput with the addition of the ECWA to WRP and WRP+CMMBCR. But it can be seen that the decreased throughput is very small.

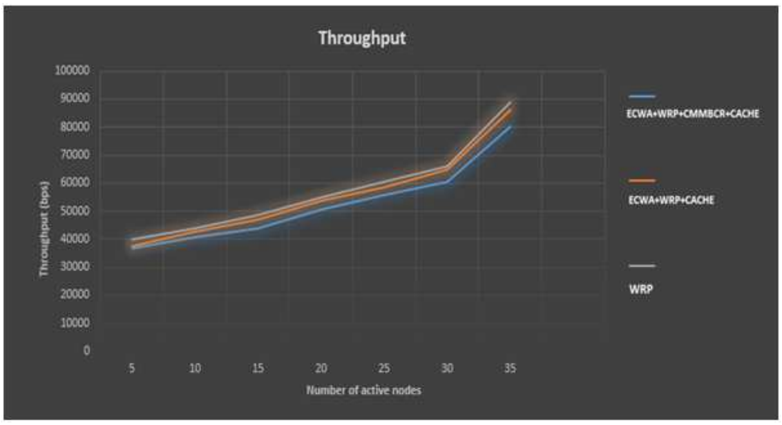

Figure 4: Comparison Graph for Throughput

The Figure 5 shows an increase of packet loss rate with the addition of the ECWA to WRP and WRP+CMMBCR in some points and in another shows a good performance. The decreasing of packet loss rate is caused because the Cache System with its data repository, but with the sleep nodes some data can be lost.

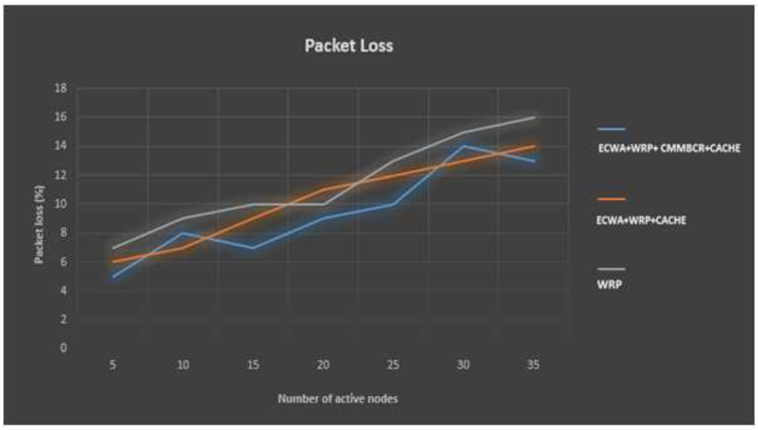

Figure 5: Comparison Graph for Packet Loss

V. CONCLUSIONS

This study demonstrates that in scenarios where the reduction in energy consumption is essential, the proposed solution is beneficial with a reduction in energy consumption. The other parameters (throughput and latency) were slightly affected, but these parameters continued performing well compared with the simulation results. Therefore, this work shows that there is a considerable reduction in energy consumption without degrading much other parameters. As a future work, we intend to implement the ECWA in a sensitive application scenarios, and ECWA associated with cache system will be studied with other routing protocols.

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